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- 1 1. A method for dewatering biological sludge that has been digested by a thermophilic
2 digestion process comprising:
3
4 a. adding a polymeric quaternary ammonium compound, as primary component, to the
5 biological sludge; and
6
7 b. adding a polyacrylamide to the biological sludge;
8
9 such that any combination of the polymeric quaternary ammonium compound and of the
10 polyacrylamide enhances dewatering of the sludge.
- 1 2. The method for dewatering biological sludge according to claim 1, wherein the polymeric
2 quaternary ammonium compound is from the di-allyl di-methyl ammonium chloride
3 (DADMAC) family.
- 1 3. The method for dewatering biological sludge according to claim 1, wherein the polymeric
2 quaternary ammonium compound is from the epichlorohydrin di-methyl amine (epi-DMA)
3 family.
- 1 4. The method for dewatering biological sludge according to claim 1, wherein the polymeric
2 quaternary ammonium compound is added directly to the sludge and, upon formation of
3 microflocs of the sludge from the polymeric quaternary ammonium compound, wherein the
4 polyacrylamide is a cationic polyacrylamide and is added to form a floc that dewateres the
5 sludge.
- 1 5. The method for dewatering biological sludge according to claim 4, wherein the polymeric
2 quaternary ammonium compound and the cationic polyacrylamide are in an approximately
3 1:1 ratio, with the cationic polyacrylamide having a higher molecular weight than the
4 polymeric quaternary ammonium compound does.
- 1 6. The method for dewatering biological sludge according to claim 4, wherein ratio of the
2 polymeric quaternary ammonium compound with respect to the cationic polyacrylamide
3 ranges from about 1:10 to about 20:1.
- 1 7. The method for dewatering biological sludge according to claim 4, wherein the polymer
2 concentration to solids ratio of total polymer dosage requirement in relationship to
3 percentage of solids component of the sludge is between about 50 ppm:1 percent and about
4 300 ppm:1 percent.
- 1 8. The method for dewatering biological sludge according to claim 1, wherein the polymeric

quaternary ammonium compound is added directly to the sludge, in an amount sufficient to cause formation of a cationic overcharge within a developed microfloc system, wherein the polyacrylamide is an anionic polyacrylamide added for final floc formation.

9. Cancelled.

10. The method for dewatering biological sludge according to claim 8, wherein the polymeric quaternary ammonium compound and the anionic polyacrylamide are in an approximately 10:1 ratio, with the anionic polyacrylamide having a higher molecular weight than the polymeric quaternary ammonium compound.

11. The method for dewatering biological sludge according to claim 10, wherein the anionic polyacrylamide is about 40% anionic.

12. The method for dewatering biological sludge according to claim 8, wherein ratio of the polymeric quaternary ammonium compound to the anionic polyacrylamide ranges from about 1:10 to about 20:1.

13. The method for dewatering biological sludge according to claim 8, wherein polymer concentration to solids ratio of total polymer dosage requirement in relationship to percentage of solids component of the sludge is between approximately 50 ppm:1 percent and approximately 300 ppm:1 percent.

14. The method for dewatering biological sludge according to claim 1, wherein the biological sludge is mixed with primary sludge.

15. A composition comprising biological sludge that has been digested by a thermophilic digestion process, [according to claim 1 comprising] polymeric quaternary ammonium compound, as primary component, and polyacrylamide, said components being present in the composition in a ratio to enable dewatering of the biological sludge.

16. The method for dewatering biological sludge according to claim 1, wherein the polyacrylamide and the polymeric quaternary ammonium compound is used in solution or in dry form.

17. Cancelled.

18. Cancelled.

19. The method of claim 15 wherein the polyacrylamide is cationic or anionic.

20. The composition of claim 15 wherein the polyacrylamide is cationic or anionic.

21. Cancelled.

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1 22. A method for treating a sludge comprising water and thermophiles, the method comprising:
2
3 contacting the sludge with a polymeric quaternary ammonium compound and a
4 polyacrylamide to form a treated sludge;

5
6 wherein the contacting of the sludge with the polyacrylamide and polymeric quaternary ammonium
7 compound is simultaneous, or the contacting of the sludge is first with the polymeric quaternary
8 ammonium compound and then with the polyacrylamide.

1 23. The method of claim 22, without any addition of anionic colloidal material between the
2 contacting.

1 24. The method of claim 22, wherein the polymeric quaternary ammonium compound comprises
2 a molecular weight in the range of about 500,000 to about 3,000,000, and the polyacrylamide
3 comprises a molecular weight in the range of about 5,000,000 to about 15,000,000.

1 25. The method of claim 22, wherein the polymeric quaternary ammonium compound is added
2 in an amount sufficient to form microflocs of the thermophiles; and wherein the
3 polyacrylamide is added in an amount sufficient to agglomerate the microflocs into flocs for
4 dewatering.

1 26. The Method of claim 25 wherein the polymeric quaternary ammonium compound comprises
2 at least one selected from the group consisting of di-allyl di-methyl ammonium chloride
3 (DADMAC) compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 27. The method of claim 25, wherein ratio of the polymeric quaternary ammonium compound
2 to the cationic polyacrylamide is in the range of about 1:10 to about 20:1.

1 28. The method of claim 25, wherein a concentration of quaternary ammonium compound and
2 polyacrylamide to the percentage of thermophiles in the sludge is in the range of about 50
3 ppm:1 percent to about 300 ppm:1 percent.

1 29. The method of claim 22, wherein the polymeric quaternary ammonium compound is added
2 in an amount sufficient to cause formation of the thermophiles into a developed microfloc
3 system having a cationic overcharge, and wherein the anionic polyacrylamide is added for
4 final floc formation.

1 30. The Method of claim 29 wherein the polymeric quaternary ammonium compound comprises
2 at least one selected from the group consisting of di-allyl di-methyl ammonium chloride
3 (DADMAC) compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 31. The method of claim 29, wherein ratio of the polymeric quaternary ammonium compound
2 to the cationic polyacrylamide is in the range of about 1:10 to about 20:1.

1 32. The method of claim 29, wherein total concentration of quaternary ammonium compound

1 and polyacrylamide to the percentage of thermophiles in the sludge is in the range of about
2 50 ppm:1 percent to about 300 ppm:1 percent.

1 33. A method for treating a sludge comprising water and thermophiles, the method comprising:
2
3 adding to the sludge a polymeric quaternary ammonium compound.

1 34. The method of claim 33, wherein the polymeric quaternary ammonium compound comprises
2 a molecular weight in the range of about 500,000 to about 3,000,000.

1 35. The method of claim 33, wherein the polymer is added in an amount sufficient to form
2 microflocs of the thermophiles, and wherein the polyacrylamide is added in an amount
3 sufficient to agglomerate the microflocs into flocs for dewatering.

1 36. The method of claim 35 wherein the quaternary ammonium moiety comprises at least one
2 selected from the group consisting of di-allyl di-methyl ammonium chloride (DADMAC)
3 compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 37. The method of claim 35, wherein a concentration of polymer to the percentage of
2 thermophiles in the sludge is in the range of about 50 ppm:1 percent to about 300 ppm:1
3 percent.

1 38. The method of claim 33, wherein the polymer is added in an amount sufficient to cause
2 formation of the thermophiles into a developed microfloc system having a cationic
3 overcharge.

1 39. The method of claim 38 wherein the quaternary ammonium moiety comprises at least one
2 selected from the group consisting of di-allyl di-methyl ammonium chloride (DADMAC)
3 compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 40. The method of claim 38, wherein a concentration of polymer to the percentage of
2 thermophiles in the sludge is in the range of about 50 ppm:1 percent to about 300 ppm:1
3 percent.

1 41. (New)A sludge composition comprising:
2 water;
3 acrylamide;
4 a polymeric quaternary ammonium compound; and
5 thermophiles.

1 42. The sludge of claim 41, wherein the sludge composition is free of added anionic colloidal
2 material.

1 43. The sludge of claim 41, wherein the polyacrylamide, thermophiles and polymeric quaternary
2 ammonium compound were contacted together simultaneously, or the thermophiles were

1 contacted with the polymeric quaternary ammonium compound at a first time, and the
2 thermophiles were later contacted with the polyacrylamide at a second time, without the
3 addition of any anionic colloidal material to the composition between the first and second
4 times.

1 44. The sludge of claim 41, wherein the polymeric quaternary ammonium compound comprises
2 at least one selected from the group consisting of di-allyl di-methyl ammonium chloride
3 (DADMAC) compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 45. The sludge of claim 41, wherein a ratio of the polymeric quaternary ammonium compound
2 to the cationic polyacrylamide is in the range of about 1:10 to about 20:1.

1 46. The sludge of claim 41, wherein a concentration of quaternary ammonium compound and
2 polyacrylamide to the percentage of thermophiles in the sludge is in the range of about 50
3 ppm:1 percent to about 300 ppm:1 percent.

1 47. The sludge of claim 41, wherein, wherein the polymeric quaternary ammonium compound
2 comprises a molecular weight in the range of about 500,000 to about 3,000,000, and the
3 polyacrylamide comprises a molecular weight in the range of about 5,000,000 to about
4 15,000,000.

1 48. A sludge composition comprising:
2 water;
3 a polyacrylamide;
4 a polymeric quaternary ammonium compound; and
5 microflocs of thermophiles.

1 49. The sludge of claim 48, wherein the sludge composition is free of added anionic colloidal
2 material.

1 50. The sludge of claim 48, wherein the polyacrylamide, thermophiles and polymeric quaternary
2 ammonium compound were contacted together simultaneously, or the thermophiles were
3 contacted with the polymeric quaternary ammonium compound at a first time, and the
4 thermophiles were later contacted with the polyacrylamide at a second time, without the
5 addition of any anionic colloidal material to the composition between the first and second
6 times.

1 51. The sludge of claim 48, wherein the polymeric quaternary ammonium compound comprises
2 at least one selected from the group consisting of di-allyl di-methyl ammonium chloride
3 (DADMAC) compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

1 52. The sludge of claim 48, wherein a ratio of the polymeric quaternary ammonium compound
2 to the cationic polyacrylamide is in the range of about 1:10 to about 20:1.

1 53. The sludge of claim 48, wherein a concentration of quaternary ammonium compound and

polyacrylamide to the percentage of thermophiles in the sludge is in the range of about 50 ppm:1 percent to about 300 ppm:1 percent.

54. The sludge of claim 48, wherein, wherein the polymeric quaternary ammonium compound comprises a molecular weight in the range of about 500,000 to about 3,000,000, and the polyacrylamide comprises a molecular weight in the range of about 5,000,000 to about 15,000,000.

55. A sludge composition comprising:
water;
a polyacrylamide;
a polymeric quaternary ammonium compound; and
an agglomeration of microflocs of thermophiles.

56. The sludge of claim 55, wherein the sludge composition is free of added anionic colloidal material.

57. The sludge of claim 55, wherein the polyacrylamide, thermophiles and polymeric quaternary ammonium compound were contacted together simultaneously, or the thermophiles were contacted with the polymeric quaternary ammonium compound at a first time, and the thermophiles were later contacted with the polyacrylamide at a second time, without the addition of any anionic colloidal material to the composition between the first and second times.

58. The sludge of claim 55, wherein the polymeric quaternary ammonium compound comprises at least one selected from the group consisting of di-allyl di-methyl ammonium chloride (DADMAC) compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.

59. The sludge of claim 55, wherein a ratio of the polymeric quaternary ammonium compound to the cationic polyacrylamide is in the range of about 1:10 to about 20:1.

60. The sludge of claim 55, wherein a concentration of quaternary ammonium compound and polyacrylamide to the percentage of thermophiles in the sludge is in the range of about 50 ppm:1 percent to about 300 ppm:1 percent.

61. The sludge of claim 55, wherein, wherein the polymeric quaternary ammonium compound comprises a molecular weight in the range of about 500,000 to about 3,000,000, and the polyacrylamide comprises a molecular weight in the range of about 5,000,000 to about 15,000,000.

62. A sludge composition comprising:
water;
thermophiles; and
a copolymer comprising moieties of quaternary ammonium and acrylamide moiety.

- 1 63. The sludge of claim 62, wherein the sludge composition is free of added anionic colloidal
2 material.
- 1 64. The sludge of claim 62, wherein the quaternary ammonium moiety comprises at least one
2 selected from the group consisting of di-allyl di-methyl ammonium chloride (DADMAC)
3 compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.
- 1 65. The sludge of claim 62, wherein the copolymer is present in an amount sufficient to form
2 microflocs of the thermophiles.
- 1 66. The sludge of claim 62, wherein the copolymer is present in an amount sufficient to cause
2 formation of the thermophiles into a developed microfloc system having a cationic
3 overcharge.
- 1 67. A sludge composition comprising:
2 water;
3 thermophiles; and
4 a polymeric quaternary ammonium compound.
- 1 68. The sludge of claim 67 wherein the quaternary ammonium moiety comprises at least one
2 selected from the group consisting of di-allyl di-methyl ammonium chloride (DADMAC)
3 compounds and epichlorohydrin di-methyl amine (epi-DMA) compounds.
- 1 69. The sludge of claim 67, wherein the polymer is present in an amount sufficient to form
2 microflocs of the thermophiles.
- 1 70. The sludge of claim 67, wherein the polymer is present in an amount sufficient to cause
2 formation of the thermophiles into a developed microfloc system having a cationic
3 overcharge.
- 1 71. The sludge of claim 67, wherein, wherein the polymeric quaternary ammonium compound
2 comprises a molecular weight in the range of about 500,000 to about 3,000,000.